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XIV. CONTROL SYSTEM FACILITIES

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The control system planned for the Energy Doubler/Saver would represent a melding of new facilities (offered by modern technology) with a distillation, based upon experience, of the facilities that have been found to be necessary, desirable or useful in existing subsystems of the accelerator. In addition to providing a communications scheme for monitoring and setting devices distributed around the four mile circumference of the ring, the existing control system provides a variety of facilities: a Clock System for synchronizing events relative to significant times in the accelerator cycle, an Abort System for allowing a detector (at any location in the ring) a method of informing the abort magnet power supply that the beam should be dumped, a Current-Regulation System for the ring magnet power supplies, and a Data Collection and Control Facility for diagnostic and tuning purposes and for keeping the operator in the control room informed. With the exception of the power supply regulation system (which is discussed elsewhere) a description of the Doubler control facilities is presented in the following paragraphs.

A. Doubler Clock System

A new, dedicated transmission cable, which runs from service building to service building around the ring, is used to synchronize devices scattered around the ring with the Doubler cycle and to synchronize the Doubler itself with the Main Ring and/or Booster.

The transmission cable carries the output of a free running, bi-polar, one megahertz oscillator onto which a number of reference times (start of Doubler ramp, beginning of Doubler flat-top, etc.) have been encoded in the form of phase reversals. The reference times together with the oscillator are typically used to provide trigger pulses to digital electronics such as waveform generators. The one megahertz oscillator fixes the timing resolution of the trigger pulses at one microsecond, which is adequate for almost all devices. The number of distinct references and the range of the Doubler clock would initially be chosen as eight references and one hundred twenty-eight seconds, respectively, which should be adequate for accommodating most complex operating modes with widely different cycle times. This type of clock system represents a straightforward extension of the timing and synchronization facilities used throughout the existing accelerator subsystems.

B. Doubler Abort System

A means for dumping the beam quickly, upon detection of a potentially hazardous situation (e.g., a quench), will be required for Doubler operation. A new, dedicated transmission cable around the ring together with an abort-input-panel in each service building is needed to provide this facility. The abort-input-panels would receive triggers from devices (loss monitors, etc.) which detect the potentially hazardous condition; the transmission cable is used to convey the information from the service building to the abort magnet power supply as quickly as possible. Typically, the delay time in transmitting the firing pulse from the worst-case service building to the abort magnet power supply is 100 microseconds--a delay which is ordinarily negligible in comparison with the rise

time of the abort magnet. This scheme for communicating the firing pulse to the abort magnet power supply represents a straightforward extension of the existing main ring abort system. For the Doubler abort system either one or two new transmission cables will be required, depending upon the details of the dump(s) for clockwise and counter-clockwise acceleration.

C. Doubler Data Collection and Control Facilities

The amount of hardware and software required to support an accelerator as large as the Doubler is expected to be comparable to that of the existing Main Ring. Control system electronics (vacuum readout electronics, timing channel outputs, correction element power supply controllers, etc.) will be located in relay racks at each service building. Serial communications facilities, providing both programmed input/output and high-speed block transfer capabilities, will be supported with new transmission line cables which connect the control room and Cross Gallery with the service buildings. A single front-end mini-computer, located in the Cross Gallery, is used to manage and coordinate the communications links.

The control station electronics located in each service building make use of a standard, parallel-bus structure provided by a CAMAC crate (IEEE-583). An extensive repertoire of interface electronics for this bus structure is available off-the-shelf. Provisions for three types of distributed intelligence facility are accommodated at the service building control stations: (1) intelligent modules, supported off the CAMAC crate, which would, for example, generate waveforms or provide simple, dedicated closed-loop control, (2) a portable, intelligent terminal which connects into the CAMAC crate and provides local diagnostic and display facilities and (3) an

intelligent, dual-ported crate controller which allows one to trade off a large fraction of the conventional monitoring from the host computer system. These three varieties of distributed intelligence, which are available and supported within the structure of the existing control system, are made possible by the products of Large Scale Integration in the form of microprocessors. Since faster, cheaper and more powerful LSI components will become available during the development and construction of the Doubler, it will be attractive to rely more heavily on the types of distributed intelligence discussed above.

The incorporation of the Doubler's control needs into the existing control system would be quite difficult unless the structure of the existing system were reorganized and the processing power of the existing system were enhanced. A computer acquisition project which would provide such reorganization and enhancement is currently scheduled and budgeted for FY80 under Accelerator Improvement Projects. During FY79 the major controls effort relative to the Doubler will be construction and installation of the facilities to be used in conjunction with the sector test. New transmission line cables have recently been installed around the ring to support these facilities. CAMAC crates and interface electronics are installed in Service Building A1. Future growth is expected to proceed in parallel with the installation of magnets in the tunnel.